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An Updated Look at Lithium Production

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Topic: Supply/Production
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Just over a year ago, and spurred by an article in Time, I wrote a post on the possible global supply of lithium, which is used in renewable batteries, and a major choice for use in the batteries of electric vehicles, such as the Chevy Volt. Since the story has acquired more recent interest this week, and with new information, it is worth re-visiting the topic.

I began the original post by noting that our first introduction to these batteries was in our role as an Explosives Lab when we found out - in a series of experiments a long time ago - that they can blow up if handled wrongly. And it turns out that such a risk is still around, though not that common. But to put the event in context:

> Fifteen incidents in the last two decades were serious enough to warrant a decision to re-route a plane or perform an emergency landing, according to FAA data.
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> For instance, in 2008, there were nine battery accidents resulting in two minor injuries. To put that figure in perspective, that year 3.3 billion lithium batteries were transported on 77 million flights, including 56 million passenger and combination passenger/cargo flights.
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> Based on that data, one's chances of being on the same flight with someone who suffers a minor injury because of a malfunctioning battery was about 1 in 28 million in 2008. In comparison, the one-year odds of dying from a car accident in the U.S. are 1 in 6,584, according to the National Safety Council.

Since we also look at processing, I became curious about where and how the lithium is mined. Recently, however, h/t to JoulesBurn, there was an article by Jack Lifton explaining some additional production issues. So what I thought I'd do is to integrate some of this additional information into a more up-to-date post.

It turns out that most lithium comes from salt lake deposits such as those in Chile and Bolivia.

The biggest deposit in the world lies in the Salar de Uyini, Bolivia, which is also the world's largest salt flat. A quick look through Google Earth gives the location, with the white in the picture being the salt flat, and not snow. La Paz, the capital of Bolivia is at the top.

The world's largest lithium deposit is at Salar di Uyuni (Google Earth)

The lithium is found in the crystallized salt, and in the brine that underlies the crust. As the world gears up to demand more, Bolivia is determined to keep as much of the "value added" part of the processing to itself. Thus the intent has been that the state would initially act alone in industrializing their deposits, and not look for foreign partners until 2013. Unfortunately its attitude has not drawn a lot of excitement from the world press, since there appears to be more than enough for current demands available from elsewhere.

> Chile provides 61% of lithium exports to the US, with Argentina providing 36%, says the US Geological Survey (USGS), with Chile having estimated reserves of 3m tonnes, and Argentina about 400,000 tonnes. . . . . Lithium production via the brine method is much less expensive than mining, says John McNulty, analyst at global bank Credit Suisse. Lithium from minerals or ores costs about $4,200-4,500/tonne (€2,800-3,000/tonne) to produce, while brine-based lithium costs around $1,500-2,300/tonne to produce.
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> Melting snow from the Andes Mountains runs about 130 feet (39.6 meters) underground, into lithium deposits, then gathering into pools of salt water, or brine. The brine is pumped out from under salt flats such as Chile's Salar de Atacama, and spread among networks of ponds where the desert sun and high altitude provide a beneficial environment for evaporation.
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> It takes about a year for the brine to reach a lithium concentration of 6%, when it is shipped to a plant to be purified, dried and crystallized into lithium carbonate, which then is granulated into a fine powder for battery makers. Lithium stores a very large amount of energy for its volume, which makes it perfect for electronics.

Unfortunately for those who are expecting electric cars to spring out of the woodwork in the next

few years (remembering that the President's plan calls for 1 million plug-in hybrids by 2015) Mitsubishi estimates that the world will need 500,000 tons per year at full ramp up. The Salar di Uyuni deposit in Bolivia holds at least 9 million tons, although the country has, in total, perhaps as much as 73 million tons. The only progress to date is a pilot plant that was intended to produce some 40 tons by the end of last year, as it geared up to full production, with the product coming from brine processing. The world supply of lithium itself is considered to be 28.4 million tons, equivalent to 150 million tons of lithium carbonate. The USGS has estimated that the deposit can produce about 5.4 million tons of lithium, relative to a total US reserve base of 410,000 tons. With the slump in the world economy last year demand dropped, and so lithium producer SQM SA has recently dropped the price 20% since there is more than enough to go around.

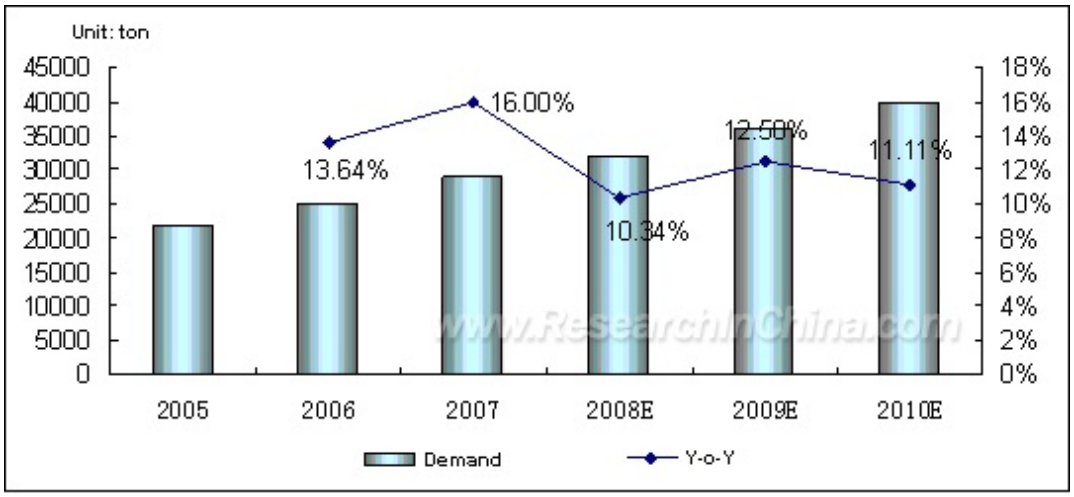
World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[2]	Reserve base[2]
	2005	2006[e]		
United States	W	W	38,000	410,000
Argentina[e]	1,980	2,000	NA	NA
Australia[e]	3,770	3,800	160,000	260,000
Bolivia	—	—	—	5,400,000
Brazil	242	475	190,000	910,000
Canada	707	710	180,000	360,000
Chile	8,270	8,300	3,000,000	3,000,000
China	2,820	3,000	540,000	1,100,000
Portugal	320	325	NA	NA
Russia	2,200	2,200	NA	NA
Zimbabwe	260	250	23,000	27,000
World total (rounded)	[3]20,600	[3]21,100	4,100,000	11,000,000

World Resources: The identified lithium resources total 760,000 tons in the United States and more than 13 million tons in other countries.

Source USGS

Of course that all depends on how Chinese demand changes in the next short while.



Source Research in China

In terms of how much lithium goes into a battery, it is about 20 lb for an EV, and about 0.1 oz for your cell phone. However there are other industrial uses for lithium, so that at present only about 25% of world production ends up in a battery.

Part of the problem with the Bolivian deposit, as Jack Lifton noted is that the deposit is contaminated with magnesium, which is also true at the Atacama deposit in Chile, except that while the Mg/Li ratio there is 6.4 to 1, the deposit is 0.15% Lithium. At Hombre Muerto the Argentinean deposit, the Mg/Li ratio is down to 1.37 to 1, making it easier to produce, even though the grade is lower, at only 0.062% Li. Unfortunately the Bolivian deposit has only a 0.028% lithium, while an Mg/Li ratio of 19.9:1 so that it has both a poorer grade, and a higher Mg content. To add to these disadvantages, being high in the Andes means that evaporation is not as fast, and so processing costs go even further. This is especially true since the lake apparently floods every year, slowing evaporation even further.

So put it all together, and, for the moment, the production of much lithium from Bolivia might be a bit further in the future than they currently expect. Which is perhaps why the plant gets being pushed further and further into the future. By November last it had been put back to 2014. (And the claim that the technology will all be homegrown is a little more suspect.)

> . . . companies like Japan's Sumitomo and Mitsubishi, and South Korea's state-run Kores -- Korea Resources Corporation, are helping the government find the best way to extract lithium from Uyuni "free of charge," but will be the preferential buyers of Bolivia's lithium carbonate.

Lithium is also produced from coarse grained igneous rocks called pegmatites, with spodumene being the most common. American mines were in the Carolinas, but closed since brine processing is cheaper than the mining and processing of the hard rock.

Geothermal power plants draw hot brine from underground as a power source, and these brines can contain dissolved minerals. Thus, for example the seven Geothermal plants at the Salton Sea are reported to be able to produce up to 16,000 tons of lithium per year. The facilities are better known as a source of zinc (pdf). However the potential as a source of lithium is becoming increasingly recognized.